



UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
ATOMIC SAFETY AND LICENSING BOARD

In the Matter of

NEXTERA ENERGY SEABROOK, LLC

(Seabrook Station, Unit 1)

Docket No. 50-443-LA-2

ASLBP No. 17-953-02-LA-BD01

Hearing Exhibit

Exhibit Number:

Exhibit Title:

~~**MAY CONTAIN PROPRIETARY INFORMATION**~~
~~**SUBJECT TO PROTECTIVE ORDER**~~

August 28, 2020

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SUPPLEMENTAL TESTIMONY OF VICTOR E. SAOUMA, PH.D
REGARDING LICENSE CONDITIONS IN LBP-20-09

1. The purpose of this Supplemental Testimony is to discuss the reasons for my expert opinion that the Atomic Safety and Licensing Board (ASLB) should modify License Conditions (c), (d), (e), and (f) in LBP-09, the ASLB's Initial Decision (Ruling on Reformulated Contentions) (Aug. 21, 2020) for monitoring of Alkali Silica Reaction (ASR) at Seabrook Station." In addition, my Supplemental Testimony proposes specific language for making those modifications.

License Condition (c)

2. "Check 3" is a mandatory license condition requiring NextEra Energy Seabrook, LLC (NextEra) to "check the reliability of the extensometer threshold" for the purpose of evaluating the "consistency of expansion behavior over the entire range exhibited at Seabrook Station." LBP-20-09, slip op. at 94. Check 3 is important because of significant potential variability in the Seabrook concrete, including between specimens that appear to be "identical." *Id.*, slip op. at 95.
3. Check 3 requires an "engineering evaluation" if the periodic expansion check shows any of several conditions, including through-thickness expansion approaching the test program limits or where the general trend of expansion behavior at Seabrook significantly departs from the expansion behavior of test specimens used in the LSTP. *Id.*
4. In LBP-20-09, the ASLB found that NextEra's ten-year interval for monitoring the Check 3 extensometers is inadequate to provide adequate protection of public health and safety. LBP-20-09, slip op. at 96. As the ASLB observed, waiting such a long period for extensometer checks could defeat their purpose of determining "whether the extensometer threshold of 1.0 mm/m (0.1%) will assure that extensometers will be installed before through-thickness expansion approaches the expansion limit." *Id.*
5. I agree with the ASLB's conclusion that the frequency of checks on control extensometers should be increased to every six months, as specified in License Condition (c). But I do not agree this modification, by itself, is adequate to protect public health and safety. As written, the License Condition does not adequately account for the inherent

~~**MAY CONTAIN PROPRIETARY INFORMATION—**~~
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variability in the concrete, for which the extensometer monitoring program is deemed necessary as a check. LBP-20-09, slip op. at 95. Because there is no literature to guide the process, and because the ASR expansion monitoring program is the “first-of-a-kind” program (LBP-20-09, slip op. at 168), it is particularly difficult to interpret laboratory data for purposes of evaluating next steps. Therefore, I urge the ASLB to add language requiring the use of error bars, to be independently reviewed by the NRC Staff. The use of error bars would also be consistent with Dr. Mtingwa’s concern that it is difficult to interpret “any data plot if I don’t know what the error bars are.” Tr. 474.

License Condition (d)

6. In LBP-20-09, the ASLB noted that I had raised a significant concern about “the potential for ASR to cause or contribute to the fracture or yielding of reinforcing steel bars and a resulting loss of structural capacity.” *Id.*, slip op. at 126. The ASLB also found that I had identified a “plausible risk that the rebar fracture or yielding may occur in the highly stressed areas of seismic Category I structures from the negative impacts of the chemical prestressing effect.” *Id.*, slip op. at 127. Further, “[i]nsofar as future analyses suggest the stress from ASR expansion is approaching the yield strength of the rebar in one or more areas,” the ASLB found no evidence that “NextEra’s existing monitoring efforts will ensure that rebar fracture or yielding either does not occur or is detected if it has occurred.” *Id.*, slip op. at 128. Therefore, “in order to provide reasonable assurance of adequate protection of public health and safety,” the ASLB found it necessary to add License Condition (d), which requires the development of a monitoring program contingent on the results of future stress analyses. *Id.*
7. I agree with the ASLB’s conclusion as far as it goes. However, License Condition (d) leaves too much discretion to NextEra. This is a matter of concern because there is no guidance for conducting this type of monitoring. Therefore, I urge the ASLB to add the following two conditions on the monitoring program. First, it should include the use of properly placed and attuned acoustic sensors to detect rebar fracture. This topic is discussed in Ex. INT027 at 35 and Tr. 1150 Second, readings should be taken no less than every six months after commencement of the program. This interval is consistent with License Condition (c) and appropriate to the significant uncertainties surrounding the issue of rebar fracture.

License Condition (e)

8. In LBP-20-09, the ASLB concluded that monitoring levels for ASR in NextEra’s Structures Monitoring Program (SMP) “fail to provide reasonable assurance in accordance with 10 C.F.R. §§ 50.54(a) and 50.57(a) that operation of Seabrook Unit 1 will not endanger the health and safety of the public.” *Id.*, slip op. at 134. In particular, the ASLB concluded that NextEra had not shown, by a preponderance of the evidence, “that the current SMP can effectively account for an increase in the rate of ASR expansion, especially when NextEra’s own data indicates the SMP through-thickness expansion limit may be reached in 2█.” *Id.* (citing Ex. NER003).

~~**MAY CONTAIN PROPRIETARY INFORMATION**~~
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9. The ASLB itself calculated that “based on the most severe through-thickness cracking in the Tier 3 areas (5.6 mm/m or 0.56%) and assuming a steady expansion rate of 0.2 mm/m or 0.02% as observed at Seabrook Unit 1, in 2050 the maximum through-thickness expansion will be 12.4 mm/m (1.24%).” *Id.*, slip op. at 134. This expansion level is “[REDACTED] mm/m ([REDACTED]%) above the expansion limit.” *Id.* Thus, the ASLB calculated that the expansion limit would be reached by 2[REDACTED], [REDACTED] years before expiration of NextEra’s renewed license for Seabrook. *Id.*
10. The ASLB also found that “there is no conclusive evidence as to whether the through-thickness expansion rate will or will not accelerate during the next thirty years.” *Id.*, slip op. at 135. This is because of uncertainty regarding the question of where Seabrook is on “the sigmoid curve that represents the typical path of ASR expansion.” *Id.*, slip op. at 135. In fact, it is possible that “the expansion rate may increase” such that the current 6-month interval for Tier 3 monitoring may be inadequate. *Id.*, slip op. at 136.
11. In light of these calculations and analyses, the ASLB found “action must be taken by NextEra well before the through-thickness expansion limit is reached.” *Id.*, slip op. at 134. Given that NextEra’s renewed license authorizes it to operate until March 15, 2050 – five years past the time when NextEra expects Seabrook ASR to exceed the expansion limit -- the Board ruled that “NextEra must establish a tangible mechanism that will detect an increased expansion rate and timely implement more frequent monitoring intervals, if necessary, because of an increased expansion rate.” *Id.*
12. the ASLB also examined the SMP’s license condition for Tier 3 inspections at 6-month intervals, and found some significant deficiencies. First, the SMP “lacks any requirement that NextEra management timely evaluate the need for more frequent monitoring intervals if it detects a significant increase in the expansion rate or otherwise detects ‘the potential for structural loss of function in between the inspection intervals.’” *Id.*, slip op. at 128 (quoting Tr. At 1122 (Buford)). Second, while the SMP provided for “[f]ollow-up and interim inspections,” the conduct of those inspections was “at the discretion of the engineer.” *Id.*, slip op. at 138-39. Third, the SMP provided no guidance for how that discretion should be exercised. And finally, the SMP allowed NextEra to address problems by increasing expansion limits. *Id.*, slip op. at 139-40. But the development of new expansion limits could take years, and again there were no criteria for when they should be put in place.
13. Under these circumstances, the ASLB concluded that NextEra’s License Amendment Request (LAR) could not satisfy the NRC’s maintenance rule; but that the “deficiency” could be remedied by a new License Condition (e), which provides:

If the ASR expansion rate in any area of a Seabrook seismic Category I structure significantly exceeds 0.2 mm/m (0.02%) through-thickness expansion per year, NextEra’s Management will perform an engineering evaluation focused on the continued suitability of the six-month monitoring interval for Tier 3 areas. If the engineering evaluation concludes that more frequent monitoring is necessary, it shall be implemented under the SMP.

~~**MAY CONTAIN PROPRIETARY INFORMATION—**~~
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Id., slip op. at 140.

14. In my professional opinion, License Condition (e) makes a definite improvement to the SMP, by providing a quantitative criterion of 0.2 mm/m (0.02%) as a threshold for conducting an evaluation. A threshold of 0.2% would also have a strong impact on the steel yielding addressed in License Condition (d). Per NER013 (FHWA) (at 33) an equation to estimate the delay before yielding is given. Conservatively estimating past expansion of 0.1% (due to ASR and other loads) and the expansion rate threshold of 0.02, this would result in steel yielding in five years.
15. Nevertheless, License Condition (d) does not contain clear or stringent enough criteria for triggering an engineering evaluation. My concern on this issue is three-fold.
 - a. First, the term “significantly” is too vague and could be interpreted by NextEra to defer taking action unless very large expansion takes place. As the ASLB has recognized, there is no NRC or industry guidance to limit NextEra’s discretion in that regard. LBP-20-09, slip op. at 26.
 - b. Second, as the ASLB recognizes (LBP-20-09, slip op. at 135), there is “no conclusive evidence” regarding whether the rate of ASR expansion at Seabrook “will or will not accelerate during the next thirty years”. If Seabrook is in an early stage, the rate of annual crack growth could be great enough to cause damage before it is detected.
 - c. Finally, as shown in expert reports relied on by the ASLB for its decision, a growth rate of 0.02 % is extremely close to unsafe levels, if not unsafe already. As stated in a report by the Swiss Committee on Dams (Ex. NER075, cited at page 185 of LBP-20-09), five years of expansion at 0.02% per year would put Seabrook at 0.1%. *Id.*, Fig. 21.
16. Under these circumstances, I do not think it is possible for the ASLB to make a reasonable assurance finding regarding License Condition (e). Therefore, License Condition (e) should eliminate the word “significantly” and instead provide that if the expansion rate in any area exceeds 0.02 mm/m (0.02%), NextEra should perform an engineering evaluation.

License Condition (f)

17. In LBP-20-09, the ASLB recognized the potential for internal cracking or delamination that will not be detected by surface observation, and found that NextEra and the Staff lacked a “sound plan in place to detect and address internal microcracking and the potential for an unforeseen delamination.” *Id.*, slip op. at 185. And as the ASLB observed, petrography is the only means for observing microcracks. *Id.*, slip op. at 184.
18. Thus, the ASLB imposed License Condition (f), requiring that each core extracted from Seabrook Unit 1 “will be subjected to a petrographic analysis to detect internal microcracking and delamination.” *Id.*

19. The term “petrography” is generic and can be interpreted in a variety of ways. The Institution of Structural Engineers recommends that “possible delamination should be checked by coring and petrographic inspection of the cores for sub-parallel cracking.” NER012, Sect. 5.3.3. The Report of the Swiss Committee on Dams uses a number of techniques to detect micro-cracking that could lead to delamination, including: a) Fluorescent lights, b) Polarizing filters, and c) Electron and Scanning Electron Microscope (SEM). NER075 at 12-14. As demonstrated in the Swiss Dam Report, the petrographic method used affects the degree to which micro-cracks can be detected.
20. Therefore, it is important for License Condition (f) to specify the size of microcracks that should be visible using petrographic methods. As discussed above with respect to License Condition (c), the “petrographic analysis” required in License Condition (f) should be capable of detecting microcracks as small as 10 μm .

This concludes my Supplemental Testimony.